Remarks begin on page 14 of this paper.

AMENDMENTS TO THE SPECIFICATION

Please replace Paragraphs [0039], [0040], [0042], [0044], [0045], and [0049] with the following paragraphs rewritten in amendment format:

[0039] Because the hydrogen within the storage tank is in a single-phase state of liquid, the opening of the vent valve causes liquid hydrogen to travel through the vent line and exit the storage tank. The venting rate of the liquid hydrogen is substantially constant and approximately the same rate as when venting pure gas in example [[one]]1 between states 1 and 2. The venting of hydrogen at this rate continues until the hydrogen reenters or transitions back into a two-phase state of liquid and gas as indicated at state 3 in graphs 70, 80. As the hydrogen enters the two-phase state of liquid and gas, gaseous hydrogen begins to form at the top of the storage tank. The rate of venting at this point takes a considerable jump due to the venting of liquid hydrogen, as indicated by venting rate line 76 at state 3. As can be seen on the expanded portion of graph 70 in Figure 3B, the venting rate of the hydrogen continues at this high level until a sufficient amount of hydrogen in the storage tank has evaporated into the gaseous state such that the vent line begins to vent gaseous hydrogen instead of liquid hydrogen. In other words, this high rate of venting continues to occur until the liquid level of the hydrogen is below the location in the storage tank of the inlet to the vent line. In this example, the vent rate reaches a peak of approximately 2.7 kg/day and lasts for approximately 90 minutes as represented by state 4 in graphs 70, 80. Thus, between states 3 and 4 gaseous hydrogen is forming within the storage

tank and as the gas continues to form it pushes the liquid hydrogen out of the tank through the vent line.

[0040] Once the liquid level of hydrogen drops below the 95% level in the storage tank (the vent line location), the venting of the hydrogen returns to a more normal state similar to that shown in example [[one]]1 wherein the hydrogen vents at a rate of approximately 0.42 kg/day. This continues until all the liquid hydrogen has flashed off or evaporated into gaseous hydrogen as indicated at state 5 in graphs 70, 80. At this time, just as occurred in example one, there is a spike in the vent rate of the hydrogen from the storage tank as a result of the heat influx going entirely to heat the gaseous hydrogen as opposed to the heat of vaporization of liquid hydrogen occurring just prior to reaching state 5. After state 5, the venting rate decays quickly and is substantially the same as that shown in example [[one]]1 following the occurrence of state 2.

[0042] Referring now to Figures 4A-C, a method according to the principles of the present invention for operating a storage tank is shown. In this example, the storage tank is substantially the same as that used in examples 1 and 2 with the addition of a cooling shield around which the hydrogen being vented from the inner tank flows prior to exiting the outer tank. The use of a cooling shield, as described below, provides a significant advantage and reduces the overall or effective venting rate of hydrogen such that the duration the hydrogen remains in the storage tank is substantially increased. The use of a boil off cooling shield furthermore greatly reduces the large boil off peak in example [[two]]2 between states 3 and 4.

[0044] In this example, the storage tank is initially filled with hydrogen so that the liquid level of hydrogen is approximately 95% of the capacity of the storage tank, as indicated by liquid level line 92 at state 0. The initial pressure level in the storage tank also begins at approximately 0.4 MPa, as represented by pressure level line 94 at state 0. As the heat influx enters into the inner tank, the temperature of the hydrogen begins to increase and, as a result, the pressure in the storage tank also increases. When the hydrogen within the storage tank increases to a sufficient pressure, as represented at state 1, the hydrogen transitions from a two-phase state of liquid and gas to a single-phase state of liquid. As the heat continues to flow into the inner tank, the temperature and pressure of the hydrogen continues to increase until the pressure reaches the predetermined level wherein the vent valve opens to begin venting hydrogen through the vent line, as indicated at state 2. Again, the predetermined pressure is approximately 0.7 MPa as represented by pressure level line 94 at state 2. With the predetermined pressure level being reached and the vent valve opening, liquid hydrogen begins being vented from inner tank 22 and flows around cooling shield 24 prior to exiting outer tank 32. Because the venting hydrogen flows around a cooling shield, there is a first spike in the venting rate, as indicated by venting rate line 96 at state 2. This first spike reaches up to approximately 0.38 kg/day rate and rapidly decreases to below about 0.19 kg/day rate. The initial spike of about 0.38 kg/day is about the same as the initial venting rate of liquid hydrogen in Examples 1 and 2. The venting level in Example 3, however, quickly decreases to about 0.19 kg/day which is approximately half of the rate of the venting that occurs in Examples 1 and 2. The rapid decrease is a direct result of the liquid hydrogen flowing around the cooling

shield. The flow of liquid hydrogen around the cooling shield provides a reduction in the heat influx into the inner tank and, as a result, a lower rate of venting of hydrogen from the storage tank occurs. The venting of liquid hydrogen from the storage tank continues to occur at substantially this rate until the hydrogen transitions from a single-phase state of liquid to a two-phase state of liquid and hydrogen, as indicated at state 3 in graphs 90, 100. The vented liquid hydrogen is evaporated in the boil off cooling shield such that it passes through the ~~boil-off valve 28~~ outer tank 32 in a warm gaseous state, not a cryogenic liquid state.

[0045] As the hydrogen transitions from being in a single-phase state of liquid to a two-state of liquid and gas, a spike in the venting rate of hydrogen from the storage tank occurs, as indicated by venting rate line 96 at state 3. The use of cooling shield 24, however, causes the venting rate to decrease rapidly and reduces the peak venting rate to approximately 1 kg/day. This venting rate then decreases very rapidly to a lower rate which remains substantially constant as liquid hydrogen is continued to be vented from the storage tank until state 4 is achieved. Again, the vented liquid hydrogen is evaporated in the boil off cooling shield such that it passes through the ~~boil off valve 28~~ outer tank 32 in a warm gaseous state, not in a cryogenic liquid state. At state 4, the level of hydrogen gas within the storage tank has increased to a sufficient amount to cause the inlet to the vent line to be above the liquid hydrogen level and a venting of gaseous hydrogen occurs instead of a venting of liquid hydrogen. Upon reaching state 4, the venting rate of hydrogen drops and, due to the presence of the cooling shield, experiences a brief downward spike which rapidly increases to a new steady state rate of venting, as indicated by venting rate line 96 just past state 4. The

rapid increase in the venting rate of hydrogen from the storage tank immediately following the negative spike is a result of the gaseous hydrogen flowing through the cooling shield instead of liquid hydrogen. That is, the gaseous hydrogen does not have as great a cooling effect on the cooling shield and, as a result, the cooling shield has a lesser effect on the heat influx into the inner tank when gaseous hydrogen is flowing through the vent line. The venting rate of hydrogen quickly establishes a new steady state rate of just over 0.2 kg/day until the hydrogen reaches state 5 which corresponds to the hydrogen transitioning from a two-phase state of liquid and gas to a single-phase state of gas. This steady state venting rate is approximately one-half the steady state rate between states 4 and 5 in Example 2 and between states 1 and 3 in Example 1.

[0049] For example, referring now to Figure 5, a graph 110 shows the phase diagram for the hydrogen during various operating conditions of storage tank 20 and mobile platform 34 when being operated according to the principle of the present invention. Line 111 represents the state of the hydrogen within storage tank 20. Lines 112 within dome 114 ~~represent~~ <u>represents</u> lines of constant volumetric liquid level. The far left side of graph 110 outside of dome 114 represent the region wherein the hydrogen is in a single-phase state of gas while the area on the far right-hand side of graph 110 outside of dome 114 represents the region wherein the hydrogen is in a single-phase state of liquid. In this scenario, the hydrogen is at an initial level of approximately 98% liquid and 2% gas within storage tank 20, as indicated at state [[0]]<u>1</u>. Mobile platform 34 is not consuming any hydrogen from storage tank 20 at this time. As heat influx enters into inner tank 22, the temperature of the hydrogen increases and, as a result, the pressure in inner tank 22 also increases. The temperature and pressure

within inner tank 22 continue to increase until the predetermined venting pressure is reached at state 2 and vent valve 28 opens to release hydrogen through vent line 26. When vent valve 28 opens, hydrogen in inner tank 22 is in a single-phase state of liquid and liquid hydrogen is vented through vent line 26 and around cooling shield 24. As the venting continues, the quantity of hydrogen within storage tank 20 decreases and, as a result, the density of the hydrogen within storage tank 20 decreases. The density of the hydrogen within storage tank 20 continues to decrease and then, in this example, at state 3 mobile platform 34 is operated and hydrogen is delivered from storage tank 20 to fuel cell system 36 where it is consumed therein to produce electrical power. The supplying of hydrogen from storage tank 20 to fuel cell system 36 causes the pressure within inner tank 22 to decrease and approach the operating pressure level. As the pressure decreases, the hydrogen transitions from a single-phase state of liquid to a two-phase state of liquid and gas, as indicated by line 111 at state 4. As mobile platform 34 is continued to be operated and hydrogen from storage tank 20 is consumed, the level of liquid hydrogen within storage tank 20 continues to decrease while the level of gaseous hydrogen in storage tanks 20 increases. Eventually, the operation of mobile platform 34 causes the pressure level within storage tank 20 to decrease to the operating pressure as indicated by line 111 at state 5. The continued consumption in combination with controlled heating of the cryogenic hydrogen by mobile platform 34 from storage tank 20 causes the pressure level to remain substantially constant at the operating pressure level while the quantity of liquid hydrogen within storage tank 20 decreases and the quantity of gaseous hydrogen within storage tank 20 increases, as indicated by line 111 between states 5 and 6.